

**FY04 Core Support for Shuttle Environmental Assurance (SEA)
Programs and Projects**

**Status Report #2
May 15, 2004**

**NASA Contract: NAS10-03029
Task Order No. 4**



**International Trade Bridge, Inc.
1308 Research Park Drive
Beavercreek, Ohio 45432**

Executive Summary

International Trade Bridge Inc. (ITB) is supporting the Propulsion Systems Engineering and Integration (PSE&I) Office in implementing the Shuttle Environmental Assurance (SEA) Initiative. This work consists of environmental engineering, technical, business, interface, integration, management and administrative efforts required to develop, plan and integrate environmental activities for NASA's Space Shuttle Program (SSP) and for other related Agency wide environmental programs supported by the SSP PSE&I Office. This status report covers the period of February 1, 2004 through April 30, 2004.

During this reporting period ITB completed a final draft of the SEA Annual report and supported planning and briefings for the SEA face to face in May. ITB also completed reviews of SSP Change Requests related to public risk and supported Program Control Review Board (PRCB) and Integration Control Board (ICB) meetings, provided comments on a draft NASA Procedural Requirements (NPR) Range Safety document, provided a briefing for the PSE&I Manager, and supported ongoing work on the SEA collaborative studies.

Introduction

The Propulsion Systems Engineering and Integration (PSE&I) Office at Marshall Space Flight Center (MSFC) was tasked to lead the Shuttle Environmental Assurance (SEA) Initiative established by the Space Shuttle Program (SSP) Manager in 2000. SEA is to promote environmental excellence, proactively manage materials obsolescence and optimize associated resources. SEA and the MSFC PSE&I Office also support the SSP in other Shuttle related pollution prevention and environmental issues, including range safety concerns.

SEA works to proactively identify regulatory and other drivers for materials replacement, provides a forum for data sharing and communication to management, and reduces duplication of effort among the shuttle elements through establishment of effective management tools and projects that reduce NASA's environmental risks. PSE&I is working with the NASA Acquisition Pollution Prevention (AP2) Program Office at Kennedy Space Center (KSC) in the proactive identification and integration of pollution prevention, systems safety, and health risk assessments for related NASA programs and initiatives.

International Trade Bridge Inc. (ITB) is supporting the PSE&I Office in implementing the SEA Initiative. This quarterly report summarizes ITB core support for the SEA Program and Projects. This work consists of environmental engineering, technical, business, interface, integration, management and administrative efforts required to develop, plan and integrate environmental activities for NASA's SSP and for other related Agency wide environmental programs supported by NASA's Propulsion Systems Engineering and Integration Office.

Ms. Anne Meinhold is accomplishing the ITB, Inc. support to the SEA at Marshall Space Flight Center (MSFC) through Task Order 4, which began on October 31, 2003. This is the second status report for this task order and covers the period of February 1, 2004 through April 30, 2004.

Accomplishments this Reporting Period

- Tracked Program Control Review Board Directives (PRCBD) and Change Request (CR) actions addressing Columbia Accident Investigation Board (CAIB) Observations on public risk associated with Shuttle flight (S064026)
- Provided notes and comments on draft NASA Procedural Requirements (NPR) 8715, Range Safety Program
- Tracked range safety panel discussions and Integration Control Board (ICB) briefings concerning possible extension of Solid Rocket Booster (SRB) linear shaped charge
- Developed outline for collaborative study reports
- Began work on collaborative study risk assessments and environmental, safety and health assessments of currently used products and potential alternatives
- Updated material for United States Environmental Protection Agency Stratospheric Ozone Award for SEA, and provided material and certificate to SEA members and to public relations for press release
- Completed final draft of 2003 Annual Report
- Supported SEA face to face planning and preparation

- Prepared briefings for the SEA face to face (Issue Management; SEA Planning session)
- Developed PSE&I Deputy Manager Status Briefing and updated SEA issue status table

Cost Summary for this Reporting Period

47.52% of funding expended as of April 30, 2004

Status and Progress

Technical Evaluations

Change Requests

In preparation for return to flight, the PSE&I Office is reviewing and tracking formal CRs and PRCBDs that may affect more than one Shuttle element. ITB is supporting PSE&I in reviewing, commenting on and tracking the progress of CRs and PRCBDs that are related to SEA issues and other environmental and range safety concerns.

Range Safety Panel

ITB supports PSE&I in tracking work by the Range Safety Panel related to range safety issues. Issues of particular concern include a series of actions and PRCB briefings related to range safety issues identified as findings and observations by the CAIB report. ITB provided comments on PRCBD S064026 and will continue to actively track these CRs and PRCBDs through participation in PRCB meetings and review of documents. ITB summarized these CRs and how they address CAIB observations (Appendix A, Range Safety Issues/CRs). ITB's major concern with the approach taken by the Range Safety Panel is that range safety issues are not being addressed in an integrated way. Estimates of risk and decision concerning risk mitigation (such as alternate landing sites, changes in flight rules) should be made with all available information and by weighing costs and benefits.

ITB also provided notes and formal comments on a Draft NPR under development by HQ (NPR 8715, Range Safety Program) (Appendix B). This NPR would have required development of a program level risk management plan. It required compliance with Air Force risk criteria and allowed for tailoring to meet criteria. This NPR was withdrawn and will probably not be available before return to flight.

The Range Safety Panel is also assessing the feasibility and potential risk reduction that would be achieved by extending the linear shaped charge on the SRB down to the aft segment. Most of the predicted risk associated with debris following a catastrophic accident on ascent comes from the breakup of a free flying SRB over a populated area. The linear shaped charge (LSC) used to detonate the SRB in this situation does not extend to the aft segment of the booster. The Air Force model used to assess risk associated with a catastrophic accident on launch assumes that the aft segment will impact land intact, and that the fuel remaining will detonate causing a large debris impact. Data from Challenger suggest that this is possible, and RSRM (Reuseable Solid Rocket

Motor) does not have data suggesting otherwise. The Range Safety Panel has estimated that extending the LSC to the aft segment would reduce the Ec (expected number of casualties/deaths) by about a factor of 7. The Range Safety Panel will report to the ICB in May.

R&D of SSP Materials Replacement Technology and Processes

SEA Issues

The SEA team is currently working 19 issues. SEA has closed one issue, identified one new issue and facilitated mitigation of one issue by other SSP groups. Four of these issues are being addressed in collaborative studies, and ITB has major responsibility for facilitating this work by the SEA team. ITB updated a detailed table outlining the current status of these issues for a briefing to the PSE&I Deputy Manager (April 7), Appendix C.

New issues just identified by SEA include the obsolescence of HD2 Conoco grease used by all of the Shuttle elements and a concern identified by a NASA Advisory (NA-HQ-2004-01) alert that suggests that use of aqueous cleaners on high strength steel could result in hydrogen embrittlement.

SEA Issues

Issue	Category
HCFC 141b Blowing Agent	High baseline risk
1,1,1 Trichloroethane Elimination (Orbiter use)	High baseline risk
1,1,1 Trichloroethane Elimination (RSRM use)	High baseline risk
Cadmium Replacement in Plating Applications	Medium baseline risk
Hexavalent Chromium Replacement in Primers	Medium baseline risk
Hexavalent Chromium Replacement in Conversion Coatings	Medium baseline risk
Chemical Paint Stripper Alternatives	Medium baseline risk
Alternate Dry-Film Lubricant	Medium baseline risk
High volatile Organic Carbon Coatings	Medium baseline risk
Hypalon Paint	Medium baseline risk
Lead-Free Electronics	Medium baseline risk
Hexavalent Chromium in Alkaline Cleaners	Low baseline risk
Hazardous Air Pollutant inks	Low baseline risk
Methyl Ethyl Ketone Replacement	Low baseline risk
Cleaning and Verification Solvents	Low baseline risk
Perfluoroalkyl Sulfonates	Low baseline risk
3M Tapes	Closed
Brominated Flame Retardants	New
Neoflon TM /Kel F	Track/Facilitate

SEA Issue Management

ITB is updating the issue summary sheets associated with these issues, and is re-evaluating how the programmatic risk associated with these issues is assessed. Baseline risks are assessed using the Space Shuttle Program risk matrix. Risks associated with the loss of a material are assessed in terms of both probability and impact. SEA plans to assess current risk using a modification of the stoplight approach used by the Integration Office in tracking projects required for return to flight. SEA issues will be assessed in terms of technical risk and schedule/cost risk. These risks will reflect the current program risk, and are independent of the issue's baseline (without mitigation) risk. ITB prepared a briefing for the May face to face that discusses this approach.

Collaborative Studies

SEA is initiating scoping studies to provide recommendations to the SSP concerning the potential benefits of future, multi-element collaborative replacement efforts for four materials: HCFC 141b in TPS, hexavalent chromium in epoxy primers, hexavalent chromium in conversion coatings, and cadmium in plating applications. In these studies, the affected hardware elements will (1) identify common performance requirements for replacement materials; (2) summarize work done by other agencies; (3) identify potential replacements; (4) make recommendations to the Program; and (5) develop a coordinated mitigation plan. The Conversion coating study was initiated in October 2003.

The primer and cadmium studies were initiated in December 2003. A coordinated mitigation plan for these three collaborative efforts is planned for completion in FY04. Collaborative work on the replacement of HCFC-141b will be initiated during FY 2004 and the schedule will depend on return to flight activities.

ITB is supporting SEA in managing and facilitating these collaborative studies. ITB developed an annotated outline for the collaborative study reports (Appendix D). ITB will be responsible for the risk assessment and environmental health and safety screening of currently used and alternative materials and initiated that effort this quarter. The ITB staff in the AP2 Office is working closely with SEA in identifying requirements for replacement materials as well as identifying and summarizing work done by other agencies.

SEA Interface Management and Integration Support

ITB is working to develop interfaces with other NASA organizations and agencies to leverage information, aid in technology transfer, and optimize resources for the SSP and other agencies. Ms. Meinhold continued to work with the AP2 Office to share information generated by SEA and to pass on Pollution Prevention requests from the Clean Air Act Working Group and other NASA organizations. The NASA AP2 Office is providing support to the SEA in its implementation of the Collaborative Studies work and has been providing useful information and contacts to the group. ITB also continues to engage the MSFC Environmental Office and the Engineering Directorate in SEA activities and the SEA collaborative studies. ITB is also working to engage the Air Force Space Command at Peterson Air Force Base in working with SEA. Mr. Dean Dunn with Air Force Space Command is interested in collaborating with NASA and Shuttle on mitigation projects, and plans to attend SEA teleconferences and future face to face meetings.

ITB prepared give-aways and presentation material and coordinated with the MSFC Environmental Office in supporting Earth Day activities at MSFC April 15.

ITB drafted the documentation for nomination of SEA for a United States Environmental Protection Agency Stratospheric Ozone Award (October 2003). SEA won this award and Ms. Meinhold attended the award ceremony in Washington, D.C. on April 14. ITB worked with EPA to finalize the final summary of the award (Appendix E) and made copies of the award certificate and other supporting information available to SEA team members as well as public relations for a press release.

Administrative Support

Annual Report

ITB drafted the initial review draft for the SEA 2003 Annual report. This draft was completed on January 30, 2004. ITB addressed comments by the SEA team and sent out a final review draft in March. ITB made changes to this draft and prepared photographs for inclusion in the report. This draft was completed April 30. ITB is working with MSFC graphics to prepare the layout of the document. A final report is planned for early June 2004.

Manager Update

The SEA PSI team updated the PSE&I Deputy Manager once during this reporting period on SEA activities and issues. ITB had lead responsibility for these briefing materials (Appendix F).

Meetings

ITB supported the planning for the SEA face to face meeting held at the USA NSLD Building in Cape Canaveral, May 4-6. ITB supported development of meeting agendas, and coordinated the purchase of give-aways. ITB also developed and presented briefings on Issue Management and SEA Future Planning (Appendix G).

Technical Products and Deliverables

Technical reports and deliverables completed this reporting period include:

- Annual Report Review Draft and Action Requests
- Comments on PRCBD and CR actions addressing CAIB Observations on public risk associated with Shuttle flight (S064026) (Appendix A)
- Comments on 8715 Draft 1, Range Safety Panel (Appendix B)
- Issue Status Table (Appendix C)
- Collaborative Study Reports Outline (Appendix D)
- USEPA Award Summary (Appendix E)
- PSE&I Manager Status Briefing (Appendix F)
- Briefing materials: SEA Planning session and SEA Issue Management (Appendix G)

APPENDIX A

2/19/04

Range Safety Issues/CRs

Overall concerns:

1. There seems to be confusion about what is required for return to flight. Range safety CRs have been classified in PRCB data as RTF-First Flight. However, they are not identified as a CAIB RTF requirement but are responses to CAIB Observations. These actions are identified in the Shuttle Implementation plan as “Raising the Bar – Other Corrective Actions”, SSP-2.
2. Range safety issues are not being addressed in an integrated fashion. Estimates of risk and decisions concerning mitigation (such as alternate landing sites, change in flight rules) need to be made with all of the available information.
3. SSP is depending on HQ to develop risk and range safety policy and handle public concerns. HQ draft NPR 8715, Range Safety Program” has been withdrawn from coordination. SSP can’t expect guidance before RTF.
4. PSE&I has provided a series of comments on risk issues to the Range Safety Panel (Greg Oliver), including comments on actions under PRCBD S064026 (CAIB Observations 10.1-1, 10.1-2, and 10.1-30: Public Safety).

CAIB Observations:

10.1-1 NASA should develop and implement a public risk acceptability policy for launch and re-entry of space vehicles and unmanned aircraft.

10.1-2 NASA should develop and implement a plan to mitigate the risk that Shuttle flights pose to the general public.

10.1-3 NASA should study the debris recovered from Columbia to facilitate realistic estimates of the risk to the public during Orbiter re-entry.

SSP plans to address these observations by:

- 1) Depending on HQ NPR 8715, Range Safety Program (just removed from coordination) to address 10.1-1
- 2) SSP Action 2 in the RTF Implementation Plan to address 10.1-1, 10.1-2, 10.1-1-3: The Space Shuttle Program will evaluate relative public risk between landing opportunities that encompass all cross-ranges, each operational inclination, and each of the three primary landing sites. NASA will evaluate the risk posed by Space Shuttle overflight during entry and landing. Controls such as ground track and landing site changes will be considered to manage the risk to persons and property, the flight crew and the vehicle. SSP-2 is covered by the actions under PRCBD S064026.

Range Safety Guidance under development by HQ (NPR 8715, Range Safety Program).

Will require development of a program level risk management plan.

Management plan will identify launch and landing risks, show how shuttle will meet risk criteria,

tailor risk mitigation where criteria will not be met. This NPR was to be the SSP response to CAIB Observation 10.1-1. Draft NPR was not very well thought out. Required compliance with Air Force risk criteria (that Shuttle does not meet) and allowed for “tailoring” to meet criteria. Identified KSC as lead. Provided confusing guidance on a risk plan. PSE&I submitted comments. Draft was removed from coordination. SSP cannot expect guidance to be complete and SSP risk plan developed before RTF.

S064026 JSC-DA (1-1)

“Provide population overflight comparisons for all cross ranges, each operational inclination, and all three CONUS landing sites. Evaluate relative risk. Report to the PRCB”

RTF-First Flight; Under SSP-2

PRCB 4/29/04

Initial analysis was presented to the PRCB. Results showed that public risks (E_c , the predicted number of casualties per mission) associated with landing at Edwards or White Sands would be smaller than E_c for landing at KSC. However, the absolute reduction in risk is very small, and the risk associated with ferrying the Orbiter back to KSC was not included. JSC is doing some additional analysis, will look at ferrying risks too. Discussion of choosing alternate sites and devising new rules for choosing landing sites seems very premature considering SSP has not done a complete integrated analysis. Questions about public concerns were answered by referring to HQ responsibilities and planned guidance. This action is not explicitly required by CAIB report for RTF, but the SSP Implementation plan has identified it as a Raising the Bar, Other Corrective Action (SSP-2).

S064026 JSC-DA (2-1)

“Present Proposal and recommendations to the PRCB for changes to orbiter deorbit planning and landing driven by orbiter entry overflight path constraints”

RTF-First Flight; Under SSP-2

PRCB 2/26/04

S064026 JSC-DA (3-1)

“Assess the development and implementation of a plan and flight rules to mitigate the risk that shuttle flights pose to the general public”

RTF-First Flight; Under SSP-2

PRCB 4/29/02

S064026 JSC-DA (4-1)

“Assess studying the debris recovered from Columbia to facilitate realistic estimates of the risk to the general public during orbiter reentry.

RTF-First Flight; Under SSP-2

PRCB deferred

S062208 JSC-MO

“WSSH Augmentation for orbiter landing and recovery operations”

This is a request for funding to improve White Sands as a landing site. Assumption is that landing at WSSH reduces public risk, so SSP should augment the facility. This decision should be made as part of a comprehensive assessment of risk and development of plan to reduce risk to public and to crew. Ferrying the shuttle back to KSC presents public risks that should be considered.

PRCB 2/26/04

APPENDIX B

2/9/04

Comments on NPR 8715 Draft 1, Range Safety Program

The document is complex and hard to follow. Recommend to streamline requirements and responsibilities. Consider adding a flow diagram to summarize.

The included reference list is long. Consider reducing reference list by pulling out minimum requirements and deleting outdated references.

Requirements for the risk management plan include details for the risk assessment to be included, but requirements for the overall plan are not clear. Recommend a list or outline for the risk management plan.

The risk management plan for a program should include a complete analysis of the risk, including both the public, crew and mission risk from an overall systems perspective.

The risk management plan should also include guidance on community relations and addressing public concerns at appropriate decision points.

The process and documentation for coordinating/reviewing/approving NASA risk management plans with other agencies is not clear. Recommend clarify with a standardized approach.

The definition of a range operation includes "The flight of a launch or entry vehicle...at, to, or from a range, launch site, or landing site". This suggests that the risk management process and the risk management plan discussed in Chapter 3 should include the risks associated with the vehicle during launch, re-entry and landing, including risks associated with the vehicle as soon as it re-enters the atmosphere. It would be helpful to explicitly address the distinction between range and range operation so that it is clear what requirements are applicable to the range, i.e. KSC launches and which are applicable to the range operation (launch, re-entry, landing) since Shuttle will launch at KSC, fly over the entire United States and land at KSC, or an alternate site.

The document explicitly requires that NASA comply with the range safety requirements of other US agencies. The document also allows tailoring and variances from safety requirements that are based on Air Force criteria. These two requirements appear in conflict.

Please clarify if the risk criteria outlined in 3.2.1.4 are to be applied for each phase of flight or each mission.

The CAIB report included as a finding (F10.1-5) that states: "NASA efforts are underway to define a national policy for the protection of public safety during all operations involving space launch vehicles". This policy is in effect a response to this Finding. It falls short of addressing all operations since it does not include the ferrying of the Orbiter back to JSC, risks to the crew, and risks to the overall mission.

For questions concerning the comments above please contact: Steve Glover at (256)544-5016 or Anne Meinhold at (256)544-6494.

Notes

Does not apply to ferry of orbiter back to JSC.

KSC is the focal point for all matters involving range safety.

Basic approach is: Meet AF EWR -127 criteria offsite (30×10^{-4} Ec) **and**

Treat 30×10^{-6} offsite as a de minimus level.

Tailoring: If requirement is applicable, document whether or not the range user will meet the requirement as written or achieve an equivalent level of safety through an acceptable alternative. Includes the approval of deviations. Does not include approval of waivers.

Deviation: A variance that authorizes departure from a particular safety requirement that does not strictly apply or where the intent of the requirement is being met through alternate means that provide an equivalent level of safety.

Waiver: a variance that authorizes departure from a specific safety requirement where an increase in risk due to a requirements not being satisfied, has been documented and accepted.

The action for review of this NPR says that the policy is in response to the CAIB Observation 10.1-1, and the "Finalization of this policy and implementation by the Shuttle Program are necessary for Return-To-Flight". Such a RTF action was discussed in the PRCB presentation on the assessment of debris risk, but (As far as I know) the program has not formally identified this as a RTF action"

The CAIB report did include as a finding (F10.1-5) that says that " NASA efforts are underway to define a national policy for the protection of public safety during all operations involving space launch vehicles". This policy is in effect a response to a CAIB finding. It fall short of addressing a;; operations since it does not include the ferrying of the Orbiter back to JSC, nor a clear discussion of how to identify and mitigate risks associated with re-entry before a specific range is involved in the ;landing of the vehicle.